UNIVERSITY OF NATAL

PIETERMARITZBURG

SOUTH AFRICA

WATTLE RESEARCH INSTITUTE

South African Wattle Growers' Union — University of Natal —
Union Department of Forestry

REPORT FOR 1949

(SECOND YEAR)

APRIL, 1950

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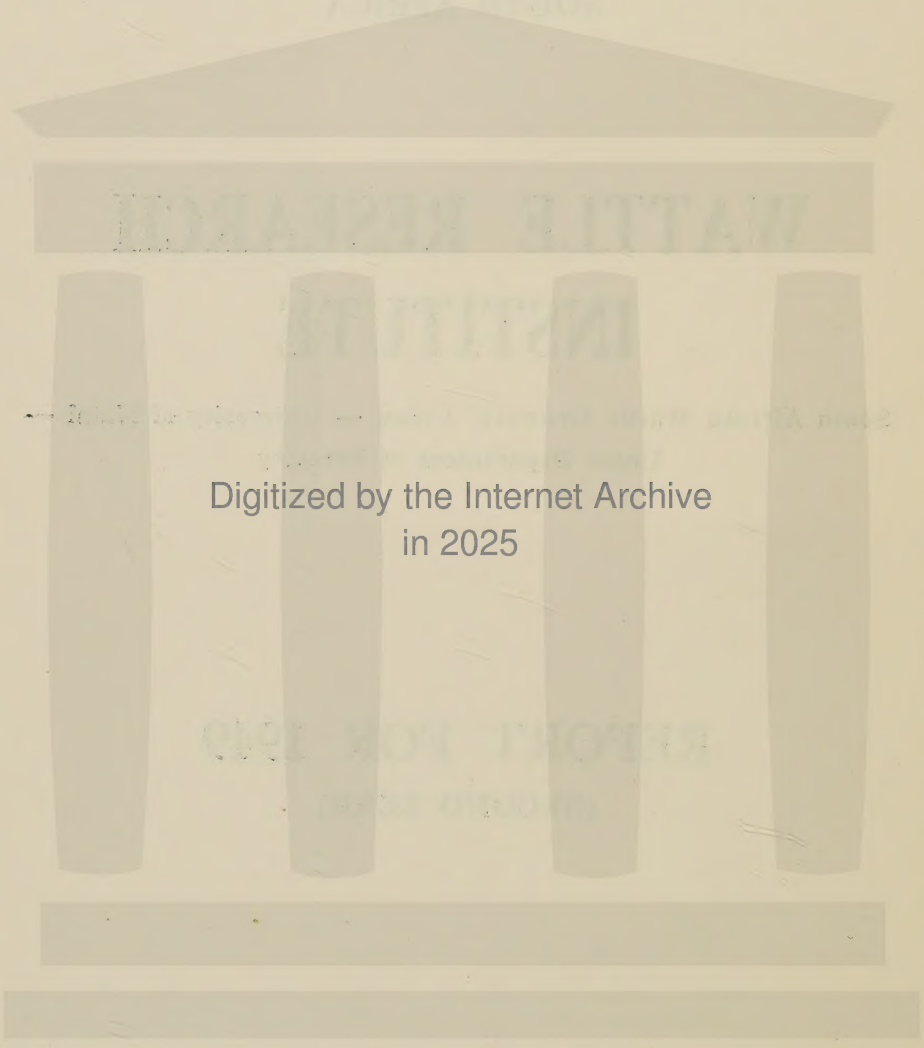

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COMMITTEE OF CONTROL OF THE INSTITUTE

Appointed by the South African Wattle Growers' Union (3) :

S. Clegg, Esq.

R. B. Fyfe, Esq.

D. R. Scott, Esq.

Appointed by the University of Natal (2) :

Professor S. F. Bush, M.Sc., D. Phil.

Principal E. G. Malherbe, M.A., Ph.D., LL.D. (Chairman.)

Appointed by the Union Government Department of Forestry (1) :

H. B. Stephens, Esq., B.Sc., Dip. For.

The Director :

Professor H. Shaw, M.Sc., Ph.D., F.R.I.C.

Honorary Secretary :

P. G. Leeb-du Toit, Esq., B.Com. (Registrar, University of Natal.)

STAFF

(MARCH, 1950.)

DIRECTOR :

H. Shaw, M.Sc.Tech., Ph.D. (Manc.), F.R.I.C.

Silviculture :

S. P. Sherry, M.A. (Oxon), B.Sc. (South Africa).

Technical Assistants:

N. J. Cunningham.

M. J. Lourens.

Miss P. M. Schofield. (*Appointed January*, 1950.)

Genetics and Plant Breeding :

A. A. Moffett, B.Sc. (Birm.), Ph.D. (Lond.).

Technical Assistants:

Miss I. A. Pedlar. (*Appointed August*, 1949.)

R. T. Brighton. (*Appointed February*,1950.)

Chemistry :

W. S. Martin, Ph.D., D.Sc. (Lond.), A.R.C.S., D.I.C., A.R.I.C.

C. G. Gordon-Gray, B.Sc.Hons. (Natal). (*Appointed March*, 1950.)

Entomology :

L. L. J. Ossowski, M.F., For.Ing., D.Sc. (Poznan). (*Appointed September*, 1949.)

Administration :

Miss A. P. J. Moberly. (*Resigned September*, 1949.)

Miss N. van Soelen. (*Appointed January*, 1950.)

Non-European :

Five.

Field Experiment Station Overseer (S.A.W.G.U.) :

M. A. Stewart. (*Appointed February*, 1950.)

FOREWORD

Last year's Report, the first, on the Wattle Research Institute perforce had to concern itself mainly with the historical and the hypothetical. It is gratifying to find the balance in the present Report beginning to shift towards the actual. While the Institute is by no means fully in its stride, the general pattern of development is becoming clearer.

In presenting the Review of Work in Progress, a warning is necessary that the work of the different Sections should not be assessed by the amount of space it takes up in the Review. There is wide disparity in the rate at which results can be expected from different types of investigation. Whereas some laboratory experiments can lead to publishable results within a matter of days, it may be many years before anything, other than that they are in being, can be said of some field trials. Furthermore, the Chemistry Section, with its high degree of dependence upon technical equipment and apparatus, has been much more seriously handicapped by the difficult supply position than have the other Sections.

This Report contains the first papers published specifically from the Institute. As could be expected, these are of a general or review nature ; some time must elapse before the flow of research reports becomes established.

As an integral part of the former Natal University College, the Institute was glad to share in the honour of the College's being granted full university status in March, 1949, as the University of Natal.

H.S.

April, 1950.

BUILDINGS AND PLANTATIONS

Main Building. Although the Institute building was substantially completed by April, 1949, many small items for correction, adjustment, or repair remained outstanding then and were dealt with intermittently during the remainder of the year. The long-delayed connection of the Institute to main drainage was completed by the Public Works Department just before the end of the year.

The furnishing of the laboratories and offices continued throughout the year as materials and equipment became available. Import control, however, worsened an already difficult supply position, and further seriously delayed the arrival of apparatus for the chemistry laboratories in particular, and some key items are still lacking.

In May, the first of the panels painted by Mr. Peter Leftwich was placed in position in the entrance hall. This portrays John Vanderplank distributing wattle seed to up-country farmers at his home at Camperdown. A leaflet reproducing the picture and giving its historical background was issued at the same time.

On the 20th May, 1949, an informal opening ceremony took place following the Annual Congress of the South African Wattle Growers' Union. Upwards of 160 visitors including wattle growers, government research officers, members of the University, and representatives of the Provincial and City Councils were received by the Director and Mrs. Shaw and conducted around the building by members of the staff. Among the features attracting particular attention were the wattle parquet floors, and there were many enquiries as to where such flooring could be obtained.

Nursery. At a cost of just over £130, a piece of ground of about two acres on the University site and near to the Institute has been fenced and a water supply laid on. Apart from the actual pipe fitting, all this work was carried out by University labour and the Institute is greatly indebted to Major J. F. Handley, the Superintendent of Grounds and Buildings, for invaluable assistance in this respect.

The nursery is now in use for the first stage planting-out of special seedlings and for seed germination trials.

Field Experiment Station. Towards the end of 1948, the Committee of Control decided to ask the Wattle Growers' Union to consider purchasing a property of 500 acres or more for use by the Institute as a field experiment station. The General Committee of the Union agreed in principle with the proposal, but the matter was referred to the Annual Congress for a final decision. Congress, meeting in May, gave its approval and instructed the General Committee to take steps to find and purchase suitable land. A Land Selection Sub-committee consisting of Messrs. W. S. R. Surendorff, J. H. Holley, Snr., R. B. Fyfe, and T. F. Mackenzie was thereupon appointed to act with officers of the Institute in selecting a suitable site, and after extensive investigations covering some thirty properties, a recommendation was made to the General Committee. As, however, the proposal involved a partially developed property at a cost higher than some members had contemplated, it was considered that the approval of a Special Congress must be sought. This Congress met on the 8th December, 1949, and agreed to purchase the farm "Bloemendal," eight miles from the centre of Pietermaritzburg, for £17,500. The farm comprises 670 acres, of which about 300 acres are at present under wattle. It includes a variety of soil types and meets all the major requirements for research investigations. The purchase was completed shortly afterwards and early in 1950 the farm was placed at the disposal of the Institute for experimental purposes.

The Institute is greatly indebted to the Union for the provision of these facilities and is especially grateful to the members of the Land Selection Committee who devoted so much time and effort to the task.

ADMINISTRATION AND FINANCE

The virtual completion of building operations and the absence of extensive additions to the research staff during the year removed the need for special meetings of the Committee of Control and it was necessary to hold only the four ordinary meetings. Owing to the absence overseas of several members, there was considerable temporary variation in the personnel of the Committee. Professor McKinnell acted for a time vice Dr. Malherbe and Professor Bayer vice Professor Bush as representatives of the Council of the University of Natal, while Mr. H. G. Bower of the Department of Forestry acted vice Mr. H. B. Stephens.

Building Account.

It is now possible to present a fairly complete statement of the total capital cost of the Institute building. In August, 1946, it was estimated that £25,000 would cover the contract price and certain additional fittings excluding technical apparatus. It is not clear just what items were taken into account in this estimate, but the following Statement indicates that, making due allowance for additions, the figure has certainly not been exceeded.

Main Building :

	£.	s.	d.
Contract price	20,360	0	0
Approved additions and alterations	2,098	3	1
Architect's fees	1,347	4	0
Laboratory benches, cupboards, etc.	1,374	0	0
Permanent fittings	135	14	6
Fixed laboratory equipment	475	3	9
	£25,790	5	4

The Department of Education contributed £10,000 towards this amount ; the balance, with the exception of a few items ranking for *pro rata* grant from the Department of Forestry, was found by the Wattle Growers' Union.

Nursery :

	£	s.	d.
Water Supply	101	17	7
Fencing	31	18	5
	£133	16	0

Site :

	£	s.	d.
Asphalting area	25	0	0
Soil	17	10	0
	£42	10	0

There will be some further expenditure on site levelling and development, but this should not exceed a few hundred pounds. Certain outbuildings also will be required in the near future.

Research Account.

The imposition of import control in June, 1949, slowed down the rate of delivery of apparatus and equipment and caused the amount expended on these items during the year to fall considerably short of expectation. This reduction in expenditure has been accentuated by an accumulation of unpaid dollar accounts due to failure to obtain release of the necessary currency.

Several appointments for which provision was made in 1949 were made only late in the year or not at all and, in consequence, salaries appear as a smaller item than had been estimated.

The summarized financial statement for 1949 appears below. It will be seen that an instalment of £1,500 was received during the year from the Forestal Land, Timber and Railways Company's gift of £2,500. This sum has provided a substantial portion of the cost of the major items of laboratory equipment so far purchased.

RESEARCH ACCOUNT

1st January, 1949, to 31st December, 1949.

Expenditure.	£	s.	d.	*Income.*	£	s.	d.
Research and Administrative Staff Salaries ..	7,034	4	2	S.A.W.G.U. Grant	4,902	18	8
Travelling and Subsistence	764	0	6	Department of Forestry Grant	4,745	18	2
Laboratory and Office Equipment and Maintenance	2,992	16	9	Forestal Grant	1,500	0	0
Library	101	9	0	Department of Education—Cost of Living allowances	186	7	10
Printing and Stationery	113	8	6	Fees for Consultation and Services	210	0	0
General Administration ..	539	5	9				
	£11,545	4	8		£11,545	4	8

STAFF

The statement appeared in last year's report that two new research posts were about to be filled. This was quite unwarrantably optimistic and despite widespread advertisement both in the Union and overseas on two occasions at an interval of nine months, it has not been possible to fill satisfactorily the post of plant physiologist. An appointment was made, however, to the post of entomologist. One technical assistant and three non-Europeans were added to the staff during the year.

Dr. L. L. J. Ossowski was appointed to take charge of the Entomology Section in September. An officer of the Polish State Forestry Service from 1928, Dr. Ossowski served with the Polish forces in Poland and in France in 1939-40. He was severely wounded and evacuated to Scotland where, later, he carried out special duties under the Forestry Commission. He came to South Africa in 1947 to join the government Department of Forestry and worked at Jonkershoek as Silviculturist and Forest Entomologist until appointed to the Institute.

Miss I. A. Pedlar joined the staff as a technical assistant in August, after a period spent in the Faculty of Agriculture. She is attached to the Genetics Section.

Miss M. W. Farmar, a graduate of Rhodes University College, held a temporary appointment in the Chemistry Section for two months early in the year to carry out some urgently required spray residue determinations.

After nearly a year and a half on the staff of the Institute, Miss A. P. J. Moberly resigned her post as Secretary-Typist in September to proceed to England, where she later took up an appointment with the Colonial Development Corporation in London. Miss Moberly has the sincere good wishes of the Institute staff for success and happiness in her new sphere.

It was found impossible to fill this vacancy before the end of the year and the Institute was fortunate to have the part-time services of Mrs. D. Johnston for most of the intervening period.

ADVISORY WORK, COMMITTEES, CONFERENCES, ETC.

Advisory.

During 1949, 61 advisory letters were written, mainly in response to enquiries from within the Union, but including also others to Tanganyika, Southern Rhodesia, Portuguese East Africa, Angola, the United States of America, Brazil, and Germany. The chief subjects of enquiry were silviculture, etc. (25), commercial and marketing (9), bark and extract (8), and soils and fertilizers (7). In some instances advice by letter has been followed up by a visit when the opportunity has occurred. A few soil samples from wattle estates have been examined and advice tendered.

The official record indicates that in addition to those who attended the Opening Day, there were 59 visitors to the Institute during the year. Many more, however, are unrecorded and the total number certainly exceeded 100. These included parties of Witwatersrand University students and Natal Tanning Extract Co. estate overseers as well as individual visitors from Northern Rhodesia, Kenya, Tanganyika, Uganda, England, and Sweden. It is to be feared that some of the growers who have called seeking advice may not have found the person best able to help them. On this account it is requested that, wherever practicable, intending visitors should make an appointment beforehand.

Several students of the University of Natal have been assisted in special investigations and advised in the preparation of theses and essays.

A special piece of advisory work was undertaken at the request of the Colonial Development Corporation when Mr. S. P. Sherry visited Tanganyika and Nyasaland to report on the prospects for wattle cultivation in those territories. Detailed plans for the establishment of a 30,000 acre wattle project to feed an 800 ton extract factory at Njombe in Tanganyika were drawn up and submitted to the Corporation, and information has been received that the establishment of this project has been begun. A summary report on the visit appears on page 29. In all, two months during March-May, 1949, were spent on the investigation and, by courtesy of the East African Tanning Extract Company, Mr. Sherry also had an opportunity to see the wattle industry established in Kenya.

From time to time the advice of the Institute has been sought by prospective purchasers, both individuals and companies, of land for wattle cultivation, and several properties have been visited for this purpose.

In September, the Institute acted as independent referee in supervising the sampling of a special export consignment of wattle extract. For lack of equipment, however, it was not possible to carry out the consequent independent analyses as would otherwise have been done.

Contact has been maintained with both South African and overseas firms actually or potentially interested in projects which would absorb some of the surplus timber arising in wattle plantations. Data have been collected and transmitted and the requirements of these industries, particularly in the matter of water supplies, have been placed before the appropriate government departments and discussed with them. During the Director's visit to England, mentioned elsewhere in this Report, the opportunity was taken to discuss some of the problems of timber utilization with the technical staffs of several industrial concerns and with research officers of the Department of Scientific and Industrial Research.

The Institute again co-operated with the various sections of the industry in organizing the Wattle Industry Exhibit at the Royal Show held in Pietermaritzburg in June.

This year, the central theme was the silvicultural aspect, and exhibits were arranged showing, for example, bark and timber yields, tree height and girth, and incidence of weeds under a variety of cultural treatments. The corresponding yields of tanning extract and of finished leather were also demonstrated.

Committees, etc.

In May, the Director, as Honorary Consultant to the Leather Industries Research Institute, again attended the Annual Meeting in Port Elizabeth of the Research Advisory Council of that Institute and took part in the annual review of the research programme. Earlier in the year, the Board of Control of the Leather Institute set up a Wattle Research Committee and Dr. Shaw and Dr. Martin were invited to serve on it. Both attended the first meeting, held in Pietermaritzburg in May, and Dr. Shaw attended a further meeting at Seaview, Port Elizabeth, in September. For the earlier meeting Dr. Shuttleworth and Mr. Roux of the Leather Institute visited the Wattle Research Institute.

The Director has attended as an invited assessor member all the meetings during the year of the General Committee of the South African Wattle Growers' Union. He and other members of the Institute staff nominated by him have served on the Research and Technical Committee of the Union.

At the invitation of the Wattle Growers' Union, Mr. Sherry drew up a draft set of rules for the Wattle Silvicultural Competition to be resumed in 1951 under the aegis of the Institute. In this matter the Institute works in collaboration with a sub-committee of the Union.

Mr. Sherry also prepared for the Union a paper on the valuation of wattle plantations to serve as a basis for arriving at valuations of plantations for fire insurance purposes. This paper appears on page 33 of this Report. Mr. Sherry served also on the Union's Fire Control Plan Committee.

All the senior members of the Institute staff, and in particular Mr. Sherry, have been deeply involved in co-operating with the Union's Land Selection Committee in the search for suitable land for a field experiment station. This has made very heavy demands upon the time of the staff and in all, not a few weeks have been devoted to this work. Some 30 properties were visited, the inspection varying from brief survey in the less promising cases to detailed examination of vegetation and soil in the most likely propositions.

Conferences, Meetings, etc.

In July, the Director travelled to London for the Second International Congress of Crop Protection. About 100 papers were presented during the ten days of the Congress and as several were being given at any one time, it was possible to attend only a selected number. Particular attention was paid to the sessions devoted to new insecticides, analytical methods, and aerial application. Several papers on selective weed control were also heard.

In addition to the lectures, the Congress proceedings included visits to Messrs. Pest Control, Ltd., where spraying by helicopter, with all the attendant ground organization, was demonstrated ; to Fernhurst Research Station of Plant Protection, Ltd. and Imperial Chemical Industries, Ltd., where many types of spraying and dusting machinery, as well as the organization of a large industrial research station, were seen ; to Kew Gardens ; and to Rothamsted Experimental Station.

While in England, Dr. Shaw took the opportunity to make personal contact with a number of large manufacturers and consumers of wood pulp products and to discuss with them the technical problems of timber utilization. This subject was also discussed with Research Officers of the Forest Products Research Laboratory, Princes Risborough.

Several other research stations and similar bodies were visited. Some of the Institute's research problems were discussed in detail and many valuable suggestions were received.

The supply position with respect to apparatus and chemicals was explored with some of the leading exporting firms and a very useful acceleration of some deliveries was secured.

In September, Dr. Shaw and Mr. Sherry attended as invited guests the First Annual Convention of the South African Section of the Society of Leather Trades' Chemists, held at Port Elizabeth. Mr. Sherry read a paper on " Wattle Silviculture in Relation to Tannin Production " and Dr. Shaw gave an address on " The Philosophy of Research " at the Annual Dinner.

On the invitation of the organizing committee, Dr. Shaw presented a paper entitled " Possibilities for Co-ordinated Wattle Research in the African Region " before sections B and F of the African Regional Scientific Conference held in Johannesburg in October. This paper is reproduced on page 24 of this Report.

Mr. Sherry gave a short address on the subject of brushwood burning in relation to erosion at a meeting at Albert Falls, sponsored by the Committee of the Albert Falls Soil Conservation District.

The Director represented the Wattle Research Institute at the formal opening in May of the new Masonite factory at Estcourt.

LIBRARY

During 1949, 26 books and 85 bulletins were added to the Library, but many standard works remain for the present unobtainable. A further 5 periodicals were added to the 35 already taken.

Arrangements have been made with many Institutions in South Africa and overseas for a regular exchange of publications. This is a valuable source of information, some of which may never appear in the scientific journals or may be accessible only with difficulty. By courtesy of the publishers, several weekly journals are received on a complimentary basis.

Growers, students, and others interested are reminded that although this literature is not normally available on loan, it may be consulted in the Library by arrangement with the Director. These facilities have been used during the year by several senior University students and others.

Gifts of books are gratefully acknowledged from the following : The Natal Tanning Extract Co., Ltd. (Rottsieper, " Vegetable Tannins ") and Messrs. Hunt, Leuchars and Hepburn Ltd. (Woodroffe, " Fundamentals of Leather Science ").

Several friends have presented old press cuttings of considerable interest in connection with the historical development of the wattle industry, and Mr. C. Sutton of " Everdon", Howick, has presented the original of a letter dated 17th October, 1895, reporting on an early consignment of wattle bark sent to Great Britain.

The Institute Library forms a very suitable repository for historical papers of this nature and further similar donations will be welcome at any time.

ACKNOWLEDGMENTS

The Institute is happy to acknowledge its indebtedness to several organizations and individuals and to express its gratitude to them for assistance rendered in a variety of ways.

To the South African Wattle Growers' Union for their generous provision of the facilities of a field experiment station.

To the Land Selection Sub-committee of the Union for their untiring and indefatigable efforts to find a suitable property for a field station.

To all the growers who are co-operating in regional field trials, without which the Institute could not function properly.

To the technical divisions of the Natal Tanning Extract Co., Ltd., and in particular to the Chemical Laboratory which on several occasions has carried out tannin analyses to assist the advisory work of the Institute pending completion of the Institute's own facilities.

To Major J. F. Handley, Superintendent of University Grounds and Buildings, for willing assistance in the development of the Institute site and surroundings.

PART II. RESEARCH REPORT

PROGRAMME OF EXPERIMENTAL WORK IN PROGRESS AND PROJECTED

As the research programmes of the Silviculture, Genetics, and Chemistry Sections appeared in last year's Report, only the additions and extensions are given here. The programme of the Entomology Section, however, is presented in full as it has not previously appeared.

(a) SILVICULTURE.

PROJECTED EXPERIMENTAL WORK.

1. Row Espacement.

An experiment is to be laid out at Bloemendal to determine the effect on yield of growing wattle at different row espacements with the same actual stocking per acre.

2. Loss of Bark Increment due to Bagworm Damage.

In co-operation with the Entomology Section, an experiment will be started to determine the effect on yield of uncontrolled bagworm attack on black wattle.

(b) ENTOMOLOGY.

WORK IN PROGRESS.

1. Bionomy of Wattle Bagworm.

Population and biotic potential studies of the wattle bagworm will be repeated annually in the next 9 years in all plantations where a population study was started in 1949. Additional plantations will be selected in the future according to requirements.

Sex factor, fecundity, and abundance will be determined, leading to a correlation between the existing number of bagworms and damage. This information will form the basis of a future key-method of sampling in order to be able to predict an outbreak of a serious infestation.

General observations and all material available will be assembled for a new monograph on the wattle bagworm.

2. Control of Wattle Bagworm Migration.

Blocks of wattle at Bloemendal and Newlands are being provided with a surrounding screen of pines in an attempt to prevent bagworm infiltration. These pines, planted in a spacing 8 feet by 8 feet, are to be neither thinned nor pruned during their 30 year cycle.

3. Chemical Control of Wattle Bagworm.

Large-scale experiments are being conducted with various insecticides under different weather conditions and also during evenings and at night.

4. Wattle Fauna.

The lesser known insect pests of wattle are being studied by observation in the field and by rearing in cages and insectary through several generations.

5. Parasites of Wattle Pests.

A special study is in progress on parasites and predators of the wattle bagworm and other wattle pests.

6. Artificial Dissemination of Fungi Parasitic on Insect Pests.

Investigations into the artificial dissemination of *Isaria* are being conducted.

PROJECTED EXPERIMENTAL WORK.

1. Systemic Insecticides.

Laboratory experiments will be made to determine the toxic effects of systemic insecticides on froghoppers and on bagworms.

2. Loss of Bark Increment due to Bagworm damage.

It is proposed to conduct investigations in conjunction with the Silviculture Section into the loss of bark increment due to bagworm damage on the tree. Plots will be laid out on all three site quality classes in 1-2 year old plantations in which the wattle bagworm is at present increasing. Half the plots will be kept free of bagworms. Measurements of height and girth will be taken twice per annum through the whole rotation and final bark measurements at the end of the cycle.

3. Effects of Brush Burning on Insect Population.

Investigations will be carried out to determine whether brush burning affects the cockchafer population and other wattle insects pupating in the soil.

4. Insectivorous Birds.

The gut of the Hadedah ibis (*Hagedashia hagedash hagedash*) will be examined and the contents compared and correlated with the different insects occurring at specific times in the wattle plantations.

It is proposed to examine approximately ten birds in each season of the year. As the Hadedah ibis is protected, these examinations cannot be started until permission to shoot the birds has been obtained from the competent authorities.

REVIEW OF WORK IN PROGRESS

(a) SILVICULTURE.

1. Thinning Experiments Initiated by the Department of Forestry.

The thinning experiments at Muirton and Hillcrest were harvested during the year, and a large number of sample trees were measured and sampled for bark analysis.

2. Thinning Experiments Initiated by the Institute.

A large replicated thinning experiment was laid out at Broadmoor. This experiment consists of nine thinning treatments in randomized blocks and is divided into four sections, each of which is to cover a different rotation period ranging from 7 to 13 years.

An experiment was laid out on the estate of the Umvoti Wattle Company at Kranskop to test the effect on the incidence of gummosis of four different rates of thinning to the same final density of stocking. In order to test also the effect of damage due to hoeing on the incidence of wood-rot infection, a split-plot technique was adopted, the sub-treatments being hand hoeing, hand pulling of weeds, and an unweeded control.

3. Weed Control Experiments.

An experiment was laid out at Cramond to test eight different methods of cultivation to secure control of weeds and wattle regrowth. The treatments include hand and implement cultivation. Costs of the different operations are being kept in an attempt to determine the cheapest method of cultivation consistent with avoidance of serious root injury.

(b) PLANT BREEDING AND GENETICS.

1. Breeding.

(a) *Inbred green wattle* (Acacia decurrens). Twenty-five trees in the first inbred generation of green wattle were selected to be selfed again. As some of these trees had attained a height of over fifty feet, bagging was found to be difficult and hazardous, while the number of suitable branches per tree was limited. The final yield of seed was low, owing partly to the destruction of bags by wind and storm and partly to the high degree of self sterility occurring in some trees.

Of the 25 trees selected, 10 failed to set seed, in spite of the fact that a considerable number of bags remained intact. In the majority of these, no pods were formed, while in others, pods formed, but were shed before reaching maturity. The 15 trees which set seed showed a range of seeds per tree from 2 to 88. Out of the 15, 9 produced 11 seeds or under per tree. The results are summarized briefly as follows :

Trees selected.	Branches bagged.	Bags torn.	Failed to set pods.	Pods shed before maturity.	Set seed.	Total seeds harvested.
25	345	178	114	16	37	336

(b) *Hybrids between green and black wattle* (A. decurrens x A. mollissima). Four sister hybrid trees which came into flower were selfed, a total of 34 branches being bagged. A total of 166 pods set on the four trees, but yielded only 81 apparently good seeds, an average of less than 0·5 seeds per pod. The yield of natural seed was higher, being just over 2·5 seeds per pod. This figure is very much below the set of natural seed in either parent.

(c) *Black Wattle selfed.* Seed was harvested during November and December from branches bagged during August and September, 1948. The yield of selfed seed per branch varied considerably from tree to tree, some showing considerable self sterility, while, on one tree in particular, the yield of selfed seed appeared to be very little less than that of natural seed. On the whole, although the seed set was greatly reduced by selfing when compared with natural seed, a good yield of seed was obtained.

Further trees were selected and bagged during August and September, 1949. Unfortunately, a very severe wind storm towards the end of September destroyed nearly 70 per cent. of the bags at the critical stage of flowering, thus greatly reducing the potential yield of selfed seed.

(d) *Height and diameter scoring of Experiment II at Sweetwaters.* The height and diameter of trees in this experiment were scored during May, 1949. This was the tenth scoring for height and the first for diameter.

Experiment II, initiated by Philip and Sherry in 1944, consists of a comparison of selfed and natural seedlings from a number of selected green wattle trees. Previous height scorings had shown a depression in vigour in the selfed seedlings, their mean height over all families being 20 per cent. less than that of natural seedlings. The 1949 scoring showed that this difference was maintained at almost the same figure, the selfed seedlings having a mean height 19 per cent. less than natural seedlings. The mean diameter of selfed seedlings was 23 per cent. less than that of natural seedlings. There were, however, considerable differences between families. In five families, selfed seedlings had a mean height 26 per cent. less than natural seedlings while in two families, G26 and G29, the difference was only 2·5 per cent. and 0·3 per cent. respectively. The mean diameter of selfed seedlings was 2 per cent. greater in family G26 and 7 per cent. less in family G29 than that of natural seedlings.

2. Pollination Mechanism.

Observations at Sweetwaters showed that both green and black wattle flowers are " worked " by large numbers of bees engaged, apparently, mainly in collecting pollen. A number of bees were caught in the plantation and the pollen masses on their legs examined. These were found to consist wholly of wattle pollen. The large number of bees observed in the plantations suggests that insect pollination may play a considerable part in seed setting. If this is the case, then the reduced seed set on selfing may be due, in part at least, to inadequate pollination.

3. Seed Germination.

Preliminary germination trials with black wattle seed divided into three size groups showed that the percentage germination was not the same in all groups following treatment with boiling water (Report for 1948). A further series of trials was planned working on the hypothesis that the sensitivity of the seed to heat treatment is not the same in all groups, and that large seed, being more sensitive, tends to be over treated by boiling water, thus reducing its capacity to germinate. If this hypothesis is correct, large seed treated at some lower temperature than boiling point should give equal or better germination than small seed. Experiments remain to be completed and results to be analysed, but the following facts have emerged :

(i) Three seed samples showed a different behaviour following treatment with hot water at temperatures ranging from 60°C. to boiling point, and held for five and ten minutes at boiling point.

  (a) Seed gathered from Sweetwaters in December, 1948, gave higher germination of large seed than of medium or small following treatment with hot water at 60°C. and 70°C. When treated with hot water at boiling point or when boiled for five or ten minutes this result was reversed, the large seed group giving poorer germination than the medium or small groups. Following treatment intermediate to these extremes, there was no difference in percentage germination in the three size groups.

(b) Two samples of commercial seed, tested over the same range of treatments, gave results very similar to those from Sweetwaters seed when scored about half-way through the germination period. By the time germination was complete, however, the difference evened up in the boiling point and five and ten minutes boiling treatments. Treated with water at 60°C. and 70°C., the large seed still gave better germination than medium or small when germination was complete.

(ii) The detrimental effect of the heat treatment on the larger seeds is not a straightforward matter of the seed being either killed or not. There appears to be a temporary inhibition of germination from which the seed can recover if unfavourable conditions, such as fungal attack, do not intervene. This effect is such as would be expected from the partial destruction or inactivation of a substance, such as an enzyme, which must be replaced before germination can proceed.

(iii) The differential germination mentioned above occurred whether germination took place on cotton wool in the laboratory or in soil in a nursery.

4. Colchicine Treatments.

A further 600 seeds were treated with colchicine using concentrations of 0·01, 0·02, and 0·03 per cent. for 24 and 45 hours. The surviving seedlings, 273 in number, have been planted out at the Field Station.

Root tips were examined from a number of seedlings treated with colchicine in 1948. About half the seedlings showed considerable islands or, in some cases, complete roots consisting of tetraploid tissue. Cells of higher polyploidy than $4n$ were not observed. Shoots of these seedlings have not been examined for polyploidy, but a technique has been worked out by which it should be feasible to make chromosome counts in likely looking shoots.

5. Twin Seedlings.

The search for twin seedlings was continued. It now appears that two types of "twins" occur, true twins and what have been termed "split seedlings." The true twins have two embryos in one seed, each embryo usually carrying two cotyledons, one of which may be rudimentary, and each having a distinct plumule. The two embryos may be completely separated or may be joined to a varying degree.

"Split seedlings," at first mistaken for true twins, have the appearance of seedlings which have been split longitudinally to a varying degree. When the seedling is completely split, as is frequently the case, each part has a single cotyledon and one part only has a plumule. The part without a shoot, although forming roots vigorously for a time, invariably dies.

To date, 125,000 seeds have been germinated and examined. These have yielded 56 true twins and 58 split seedlings. So far, no pairs differing in chromosome number have been found, but only a small number of the more robust seedlings have been examined.

6. Progeny Testing of Parent Trees.

Thirty black wattle trees have been selected and seed collected for progeny tests starting next season. Further trees will be selected in the course of the year.

7. Cytology.

Pollen mother cell divisions were examined in *A. mollissima* and in five hybrids between *A. decurrens* ($2n=26$) and *A. mollissima* ($2n=26$). Good preparations were obtained of diakinesis and the later stages of meiosis. The chromosomes paired regularly to form 13 bivalents in both black wattle and the hybrids. First and second anaphases, particularly in the hybrids, were examined for chromatin bridges indicating the presence

of relatively inverted chromosome segments. In only one case was lagging chromatin material observed at anaphase I ; this was almost certainly due to delayed unravelling of an interstitial chiasma.

From the great regularity of meiosis in the hybrids, it must be assumed that the abnormal types observed by Philp and Sherry in the progeny of a green x black wattle hybrid were due to disharmonious gene combinations and not to chromosome aberrations.

(c) CHEMISTRY.

1. Soil Survey.

Before the purchase of the farm Bloemendal by the South African Wattle Growers' Union, a number of soil depth cores were taken to assess the value of the area. Since the farm was acquired, a preliminary soil reconnaissance survey has confirmed the presence of pockets of deep red soils presumably on dolerite, with the main area of fairly heavy soils of varying depth developed on local shales. All the soil samples examined to date have been strongly acid (pH 4·5—5·5) in common with most of the wattle belt. No soils developed on Table Mountain Sandstone, the third important soil type of the wattle growing area, have yet been encountered on the farm. The survey is proceeding.

2. Fertilizer Experiments.

One major fertilizer experiment comparing the effects of nitrogen, potash, phosphate, and lime on the growth of black wattle was continued. Plots were demarcated in February, lime was applied in March, and the fertilizers in May. Regeneration was very uneven, plots crossing old extraction roads and those given a double amount of lime being particularly thin. In October, seedlings were thinned to about 12 inches apart in lines and an attempt was made to even up the stand by filling the gaps with transplanted seedlings and by re-seeding. By January, the stand was fairly even and the plots were thinned to about 4 feet apart in rows. The stand was then scored for height. The Silviculture Section co-operated in all this work.

Suitable sites on different soil types for further experiments of this kind have not yet been found.

3. Spray Residue Determinations.

The laboratory has co-operated with the Entomology Department of Cedara College of Agriculture in their work on the chemical control of wattle bagworm. The main problem was to find out how much of the spray liquid adheres to the leaves of the tree after different rates of spray application per acre. In the early part of the work, leaf samples were drawn from trees after experimental applications of single and double doses of benzene hexachloride in various oil solvents and at different concentrations of insecticide.

A technique for the determination of benzene hexachloride was worked out and applied to the leaf samples drawn by the Cedara entomologists. The results were not satisfactory, partly because benzene hexachloride is volatile and there had been wide variations in handling and length of time in storage before the samples were passed to the laboratory for examination.

A new series of trials was started, using copper naphthenate as a marker. Copper naphthenate is non-volatile and is soluble in Diesoline. The determination of copper residues showed that a much more comprehensive sampling technique is necessary to produce valid results.

(d) ENTOMOLOGY.

1. Bionomy of Wattle Worm.

(a) *Biotic Potential.* A start was made to determine the biotic potential of the wattle bagworm by studying its sex factor and fecundity. Data were obtained from over 3,000 bagworms, collected in 16 different blocks of seven different plantations.

(b) *Population study.* A detailed population study was carried out in seven plantations over an area of 400 acres. The number of bagworms per tree was determined in different age and on various site quality classes and a start was made to correlate the number of bagworms per tree with the damage.

2. Control of Wattle Bagworm Migration.

Four rows of *Pinus caribaea* in spacing 8 feet by 8 feet were planted around and also through the middle of block 33 at Newlands wattle plantation.

3. Chemical Control of Wattle Bagworm.

The acquisition by the Natal Tanning Extract Company of a machine for applying insecticidal fogs from the ground provided an opportunity to undertake a series of field trials. This machine was made available to the entomologists of Cedara and the Institute for experiments on N.T.E. estates with the co-operation of the Company's Estates Research Officer. Two experiments were carried out with the Cedara entomologists to test the efficacy of the sprayer and to determine the toxic effect of benzene hexachloride on the first three instars of the wattle bagworm. Two further experiments were carried out independently to determine the toxic effect of various concentrations of BHC and Toxaphene on the later instars of the bagworm. The results of these latter experiments are given in " Notes on the Chemical Control of the Wattle Bagworm, 1949-1950 " on page 36.

4. Wattle Fauna.

A study has been started of the bionomy of some lesser known wattle insect pests, i.e. of the cross-stick bagworm (*Gymnelema vinctus* Wlk.) and the clear-spiral bagworm (*Melasina tyrophanes* Meyr.); of two species of the family *Arctiidae*, viz. *Diacrisia lutescens* Wlk. and *D. eugraphica* Wlk.; of four species of the family *Lasiocampidae*, viz. *Pachypasa capensis* Aur., *Gonometela postica* Wlk., *Catalebeda cuneilinea* Wlk., and *Anadiasa punctifascia* Wlk.; and of *Gynanisa maia* Klug of the family *Saturnidae*.

The last-named insect went through all stages of the life cycle under observation in the laboratory and a second generation is being reared there at present.

5. Parasites of Wattle Pests.

Three different types of ichneumon and braconid parasites, one of them *Philopsyche abdominalis* Morl. and the other two so far unidentified, have been reared from wattle bagworms.

Parasites of other wattle insects were found and identified as follows :

on larvae of *Anadiasa punctifascia*, a species of *Charops*;
on pupae of *Gonometela postica* and *Catalebeda cuneilinea*, *Zygobothria convergens* (Weid) Syn. *Z. dilabida* (Vill.) (Curr.);
on larvae of *Gynanisa maia*, *Apanteles maculitarsis* Cram.;
on larvae of *Pachypasa capensis*, a hymenopterous parasite so far unidentified.

6. Artificial dissemination of Fungi Parasitic on Insect Pests.

Isaria-infected bagworms were distributed through part of the wattle plantations of Fawnleas Estate to determine the influence of these artificially infected bagworms on the rest of the bagworm population.

(e) MISCELLANEOUS.

1. Collaboration with other Organizations.

(a) *Bagworm control investigations.* Collaboration with the Entomology Department of Cedara College of Agriculture was continued. Earlier in the year this was concerned mainly with spray residue determinations in insect control experiments. Later, on the formation of the Institute's Entomology Section, the series of co-operative experiments described under Entomology was started in conjunction with Cedara and the Estates Research Department of the Natal Tanning Extract Company.

(b) *Investigations on water resources in relation to timber utilization.* The Institute has collaborated with the government Irrigation Department in producing a map showing the perennial water resources within and around the main wattle growing areas. This map will be of great value to industrialists investigating possibilities of utilizing surplus wattle timber and already copies have been sent overseas. The Irrigation Department has supplied valuable data in this same connection and has undertaken to investigate any specific problems of water supply that may arise.

(c) *Studies on the tannins of wattle species.* The collection of authentic samples of black and green wattle bark for further work at the Leather Industries Research Institute was continued. Samples of silver and golden wattle bark were collected and submitted for tanning trials.

(d) *Chemistry of wattle wood, seeds, etc.* The Chemistry Division of the South African Council for Scientific and Industrial Research is embarking upon a study of South African timbers and has sought the advice and collaboration of the Institute. Several discussions have taken place and in November, Dr. A. M. Stephen, the research officer in charge of the project, spent ten days at the Institute assembling information and data. The Chemistry Division has now started investigations on several fundamental aspects of wattle chemistry and will maintain close contact with the Institute.

2. Wattle Utilization.

Examination of the possibilities of utilizing surplus wattle timber were continued and intensified in several directions. General discussions on this subject are mentioned elsewhere in this Report. The following are the more detailed investigations made :

(a) *Floor-block manufacture.* In view of the technical success of the small experiment in preparing wattle floor-blocks, a co-operative experiment has been arranged between a grower and a floor-block manufacturer to investigate commercial possibilities.

Some 200 tons of timber was felled, cut, and prepared to the manufacturer's specification and despatched immediately to be kiln-dried. The resulting material will be manufactured into floor blocks and all wastes utilized as far as practicable. The whole procedure is on strictly commercial lines and the parcel is considered large enough to enable valid and representative costings to be made.

(b) *Pulp manufacture.* Further investigation of this problem has established certain facts.

(i) The conversion of wattle timber to high-grade dissolving pulp is difficult, but technically practicable. The sulphate process would probably be used, as the more usual sulphite process is not suitable, but yields in trial runs have not so far been satisfactory.

(ii) The minimum economic scale of operations is about 300 tons of timber per day and this would require at least ten million gallons of water per day (20 cusecs.) for process alone, with an adequate surplus for effluent dilution and disposal in addition.

(iii) The plant required for this minimum intake would require a capital outlay of at least three million pounds.

(iv) At current world pulp prices, the proposition would be a marginal one. On the other hand, there would be an assured market for pulp produced at competitive prices.

3. Wattle Timber Survey.

In the course of discussions on the problems of timber utilization, the difficulty has repeatedly arisen of lack of reliable information on the amount, size, and location of the surplus timber. In an attempt to remedy this, a questionnaire has been prepared and circulated to growers through the medium of local associations who were willing to co-operate. A fully representative response to this enquiry would be of the greatest value, but so far less than 10 per cent. of private growers have replied.

PROGRESS REPORTS AND PAPERS

POSSIBILITIES FOR CO-ORDINATED WATTLE RESEARCH IN THE AFRICAN REGION *

By H. SHAW

In recent years, wattle bark and wattle extract have taken a high place among South Africa's principal exports. In 1948, the combined export of these products represented nearly a quarter of a million tons of dry bark and it is anticipated that the value of the 1949 exports will exceed five million pounds sterling. The importance of this trade in relation to the prevailing foreign exchange difficulties is twofold. A large proportion of this wattle goes to hard currency areas, so earning valuable exchange, while the remainder consitutes the main source of vegetable tanning material within the sterling area.

Although the area under wattle in Natal and the Eastern Transvaal now probably exceeds half a million acres, the industry in South Africa is faced with an actual and potential demand that is far beyond its immediate capacity to supply.. Moreover, there is an overall world shortage of vegetable tanning materials and attention has of late turned increasingly to wattle as the one source capable of rapid expansion. Old established sources such as oak bark, quebracho, and chestnut are in diminishing supply and wattle is probably the only tanning crop now being grown on a large-scale sustained-yield basis. This is possible because it is grown as a plantation crop coming rapidly to maturity in ten years or less. This situation provides a golden opportunity for the expansion of the industry, but it carries also the responsibility of ensuring that any such development shall be on a sound basis. The industry would be ill-served by the accelerated exploitation, however profitable immediately, of existing plantations to the neglect of an adequate and regulated replacement programme. Similarly, a precipitate irruption into areas not suitable for the crop would damage not only the industry, but fundamental national interests also.

There are wide implications in the expansion of the wattle industry, for it offers possibilities other than those associated with the existence of an attractive market. With every justification, soil and water conservation, the protection of watersheds, and the control of the hydrological regime occupy a foremost position in the consideration of any agricultural development.

In this respect, the planting of large new areas of wattle can be a powerful influence, but either for good or for ill according to their management. In so far as re-afforestation is a desirable end, few crops can compete with wattle in the rapidity with which a stand providing full cover and protection for the soil can be established. A well-managed rotation can be a major factor in re-establishing the water-holding capacity of large areas of land and, in favourable circumstances, two cycles may suffice to restore worn out and partially eroded land to a condition in which it can again carry successful agricultural crops.

But, on the other hand, faulty management can just as easily lead rapidly to serious damage to both soil and water resources. Practical examples are not wanting of how,

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under good management, soil condition has been improved and dried-up streams have been restored to perennial flow, whereas on neighbouring properties, less intelligently controlled, deteriorating and disappearing soil and a frequent alternation of floods and dry river beds are accepted as inevitable.

Thus at every level there is need of scientific control of developments based on intimate knowledge of the crop in health and disease and in relation to its environment. This requirement can be met only by a thorough-going research investigation of all the factors involved and it is the purpose of the Wattle Research Institute in Pietermaritzburg to provide the men and the means for this work.

Research on the cultivation and harvesting of wattle has been carried on for many years by various government officers in the Union of South Africa. This work was of a very high standard and has contributed substantially to the present flourishing condition of the wattle industry. There were, however, some important gaps in the scheme of things, notably the lack of adequate soil studies in the wattle areas, and other lines of work discontinued in recent years because of staff difficulties. In addition to the work done by public service officers, some of the large firms interested in wattle, in particular the Natal Tanning Extract Co., have built up important research divisions.

Some ten years ago, the South African Wattle Growers' Union adopted a policy of promoting and assisting research, with the ultimate objective in mind of subsidizing a government-maintained Wattle Research Institute. The war delayed material progress with the scheme and when a positive move became possible in 1946, the relative roles of government and industry had been reversed. The Growers' Union accepted the major responsibility, with limited government assistance. Not until early in 1949, however, was the Institute building completed and it is only just beginning to function properly, though some work has been in progress for over a year. The threads of all the work previously in being, excluding that on pest control, which remains in the hands of the Division of Entomology, have been gathered together and the field experiments initiated by officers of the Department of Forestry have been taken over.

The building programme was financed by the Wattle Growers' Union and the Department of Education, while equipment and maintenance costs are met by the Growers' Union and the Department of Forestry. In each case the Growers have borne the greater part of the cost.

The Institute is organized on a tripartite basis as a Research Department of the University of Natal and is controlled by a Committee consisting of three representatives of the Growers, two of the University, and one of the Union Government Department of Forestry. By this constitution, long-term stability and the highly desirable freedom and independence of outlook are assured. As far as is known, the Institute is the only one in the world devoted exclusively to research on the production of wattle or, indeed, of any vegetable tanning material, though it is understood that a wattle research institute is about to be established in Southern India.

The staff of the Institute, though small in number as yet, is particularly well-qualified for the work confronting it, whether considered on a local or on a regional basis. It includes a leading authority on wattle silviculture, a soil chemist with many years experience in East Africa, a plant-breeder and geneticist familiar with sub-tropical conditions, and an experienced worker on chemical methods of crop protection. To these will shortly be added a forest entomologist and a plant physiologist and at a later stage a biochemist and a statistician-economist.

The basic objectives of the Institute are to facilitate an overall increase in the production of wattle tannin and to improve the yield per individual acre. This involves the extension of the areas in which wattle can be grown successfully, an increase in the yield of bark per acre, and an increase in the tannin content of the bark. Contributory factors are reductions in the losses due to pest, disease, climatic conditions, and faulty harvesting and marketing.

Each problem arising, whether from existing plantations or in the course of a programme of expansion, will be studied from every accessible angle so as to ensure as far as possible that no material consideration is overlooked. This co-operative approach becomes readily practicable only when the programme of research is integrated and co-

ordinated within one organization under unified direction. It is realized, too, that extensive fundamental studies, both biological and physical, will be necessary to inspire, illuminate, and support this applied research, and provision has been made for this in the Institute. Close association with related departments of the University will also assist in this direction.

The Research Institute, because it is wholly disinterested commercially, is in a position to collect and analyse data from the industry that might otherwise be inaccessible. In many directions there is a present lack of reliable statistics necessary to provide a rational basis for developments in policy and practice, for example, the lack of adequate information about the amount and location of surplus wattle timber that might be available for by-product industries.

A number of known factors at present sets a limit upon the possible extension of the wattle-growing areas. These include rainfall, soils, liability to insect attack, and the incidence of damage by frost. Of these the last-named is perhaps of the most pressing importance, for it is tending actually to reduce to a serious extent the area at present under wattle cultivation. This phenomenon will be studied from every angle to find a solution or to mitigate the damage caused. The physiological nature and mechanism of the injury will be investigated ; modifications and innovations in cultural practice and plantation management will be tried ; a programme of plant breeding and selection has been started in an effort to find frost-resistant strains ; and soil studies will attempt to elucidate the relation of soil condition and nutritional status to the susceptibility of the plants to frost.

Silvicultural research will also investigate methods of establishment and regeneration, thinning regimes, and other cultural operations, all under a variety of environmental conditions and in relation to the incidence of disease as well as to the final yield and quality of bark and timber. The supply and economical use of labour, as well as the possibilities of mechanization, will be examined.

Among wattle growers there is no more controversial issue than the question of burning brushwood in the course of re-establishing plantations. There is little experimental and purely objective evidence on this matter and a long-term trial will be laid down to test the effect of burning and non-burning upon soil moisture relationships, erosion, soil organic matter, fertility, resistance to frost damage, etc., and on bark and timber yields. Alongside this the effects of different silvicultural practices on soil structure, rainfall penetration, and soil moisture retention will be investigated. Obviously much of the information gained in these studies will have far wider applications than to the wattle industry alone.

The plant-breeding section of the Institute is examining the genetical constitution of different *Acacia* species in order to provide a rational basis for a programme of hybridization. Fundamental studies of pollination mechanism and seed germination in the various species are in progress. New and modified breeding material is being built up by the general methods of collection, isolation of aberrant types, and physical and chemical treatment.

Perhaps the most neglected branch of wattle research, and one only now beginning to receive the attention its importance demands, is the systematic study of wattle soils. In common with many African soils, those of the wattle areas appear to be deficient in phosphate, since wattle has shown a favourable response to applications of superphosphate. Comprehensive trials are being laid down in a variety of soil types in different climatic environments and these will include nitrogen, potash, and lime, as well as phosphate, in all possible combinations. Superphosphate is, however, not necessarily the best form in which phosphate can be applied and comparisons will be made with other materials such as metaphosphate and rock phosphate. The effect of organic matter and soil acidity on the reversion of phosphate to insoluble forms is to be investigated. Other nutritional studies, including the examination of minor element requirements, will be carried out.

An extensive programme of technical investigations on wattle bark, particularly on analytical methods and grading, awaits only the arrival of the necessary apparatus and equipment. Parallel with this work will run surveys and routine analyses connected

with the silviculture and plant breeding programmes. In addition, a joint biochemical-plant physiological study of the formation and function of tannin in plant tissues is contemplated.

A big problem confronting wattle growers is the profitable disposal of the very large quantity of surplus timber that arises annually. Among the more interesting prospects are, in addition to the hard-board industries already established, the conversion of the wood to pulp for paper or rayon and the manufacture of wood floor-blocks and small turned articles. The feasibility of pulp production is very closely bound up with water supplies, but this apart, the problems to be solved are as much economic as technical and must be approached from that angle.

It remains now to consider the possibility of developments in wattle cultivation outside the Union of South Africa and to see how far the Wattle Research Institute could extend its activities to assist in this direction. It must not be overlooked, however, that the Institute, though assisted by government grants, is essentially a private foundation owing its existence to the initiative and enterprise of the South African Wattle Growers' Union and established to serve their interests. Consequently any extension of its functions or sphere of activities could be made only with the goodwill and co-operation of the South African growers.

Several important considerations indicate the part that wattle could play in the economy of some of the African territories outside the Union. The valuable part that wattle can play in rehabilitating worn-out and eroded areas has already been discussed. Further, wattle can sometimes be grown quite successfully on land that is inherently unsuitable for either general agriculture or animal husbandry. In certain circumstances it can with advantage be directly associated with other agricultural crops where it is possible to alternate blocks of trees with agricultural lands, thus providing effective shelter belts.

The relation of wattle to an indigenous native population is also of no little significance since, in addition to the labour requirements of European-owned plantations, scope is offered for the encouragement of native forestry. In broken country, or where difficult transport conditions would make the cost of the bark collected from outlying European plantations prohibitive, the requirements of an extract factory can sometimes be made up by drawing from native-owned plantations. It is of the utmost importance, however, that such native forestry should be under the closest observation and guidance of a fully competent advisory service.

The direct labour requirements of the wattle industry are considerable. Conditions vary widely, but it may be taken as a fair average figure that 30,000 acres, the approximate area necessary to provide bark for a small extract factory, will require upwards of 1,000 men while the factory itself would need about 200. If by-product industries, operating not far from the plantations, could be established, a further source of employment would be provided, offering many of the attractions of town industry, but avoiding the problems associated with the movement of labour from its natural environment.

There is a flourishing wattle industry in Kenya already well-established and producing extract. Extensive plantings have been made in the past few years in Southern Rhodesia and although none of these latter has yet reached maturity they will in due course make a substantial contribution to wattle output in Africa. More recently, interest has turned to the Highlands of Southern Tanganyika and to parts of Northern Nyasaland. At the request of the Colonial Development Corporation, an officer of the Institute has investigated the possibilities for the development of wattle cultivation in these areas and has now reported favourably thereon.

Many of the results of the programme of research in the Wattle Research Institute will be directly applicable to other areas of the African continent, but many of the problems will undoubtedly take on a peculiarly local manifestation and will require to be investigated in part, at least, under local conditions. This might necessitate the establishment of small sub-stations to serve as headquarters for field teams either attached to the Institute or operating independently, but maintaining close contact with it. At present such research as is in being in these extra-Union areas is carried out almost exclusively by commercial interests, but these organizations collaborate very closely with the

Institute and their field data are freely available to it. The services of the Institute in an advisory and consultative capacity could readily be made available and, once the necessary equipment is to hand, the analytical work required for survey and advisory purposes could be expanded almost at will to the limit of the man-power provided. Clearly, however, if the demands upon the Institute are to be substantially increased beyond the requirements of the South African industry, an expansion of staff commensurate with these additional demands would be essential. It is assumed that this expansion would be assisted from the territories concerned by annual grants or other suitable means, though it should be added that some of the commercial interests concerned are already generous supporters of the Institute.

Finally, but by no means of least importance, the association of the Research Institute with the University of Natal makes possible the specialized advanced training of students. Provision has been made for post-graduates to work for research degrees in the Institute under the joint direction of the head of the section concerned and the appropriate University teacher. Extra-Union territories can assist both themselves and the Institute by instituting research fellowships to enable senior graduates to take up such advanced studies, thus providing a supply of specialists whose academic training has been supplemented by first-hand experience of the wattle industry.

REPORT ON POSSIBILITIES FOR WATTLE CULTIVATION IN TANGANYIKA AND NYASALAND

By S. P. SHERRY

The tour described in this report was made in 1949 on behalf of the Colonial Development Corporation with a view to ascertaining whether conditions in certain selected areas in Tanganyika and Nyasaland were favourable for large-scale wattle cultivation and, if so, to draw up a scheme for the afforestation of an area in each of these territories sufficiently large to support an extract factory. Transport to Tanganyika was arranged by air via Nairobi, where the writer was met by the Deputy Manager (Forestry Division) of the Colonial Development Corporation, who accompanied him throughout his stay in Tanganyika and rendered much valuable assistance in the land survey which was carried out in that Territory.

Southern Highlands of Tanganyika.

On the 2nd April, the writer left Nairobi by air for Dar-es-Salaam. The next five days were spent in discussions with the heads of various Government departments with a view to obtaining as much information as possible about soil and climatic conditions in the area to be inspected, potential transport facilities, labour supply and regulations governing the employment of Native labour, and legislation governing the alienation of land. The Southern Highlands of Tanganyika constitute a problem area from the point of view of Native administration in that soil and climatic factors in this region are not favourable for Native agriculture and there has been for some time an annually increasing exodus of the local Native inhabitants in search of employment elsewhere in the Territory. The Government is naturally very anxious to encourage any industry in this region which will give employment to the local Native population, either directly or indirectly, thereby raising its general standard of living and checking the drift to other districts. Every facility in carrying out this investigation was, therefore, given by the various Government departments concerned, including the supply of an aerial mosaic covering part of the area concerned and the secondment of the then Assistant Conservator of Forests at Mbeya, who was familiar with the Southern Highlands, to act as guide and to organize camping and travel arrangements.

The journey from Dar-es-Salaam to Njombe, which was selected as the headquarters for the investigation, was made by train as far as Dodoma (288 miles) and thence by car via Iringa and Makumbako (319 miles) and occupied four and a half days, one day being spent inspecting the Dabaga Grasslands area near Iringa and a half day in the country near Sao Hill. Njombe was reached on the 12th April and a thorough inspection of the surrounding country was carried out between that date and the 29th April, when the return journey to Dar-es-Salaam was begun. The writer subsequently proceeded to Zomba, Nyasaland, by air via Nairobi, Salisbury, and Blantyre, on the 6th May.

The Upper and Middle Dabaga Grasslands.

This region lies immediately to the east of Iringa and forms the northern outlier of the great highland plateau which extends from Iringa southward to Tukuyu at the northern end of Lake Nyasa, a distance of about 300 miles. The topography is rather broken, particularly in Upper Dabaga, and the vegetation consists mainly of grassland with occasional patches of relict high forest. The rainfall ranges from about 40 inches in the Middle Dabaga to 45 inches or more in the Upper Grasslands, and during the dry

season, which, unlike that of the White Highlands of Kenya, lasts from May to October, mists are frequent and there is a high percentage of cloud.

A certain amount of wattle has been planted in Middle Dabaga in the form of shelter belts and small blocks established by the Native Authority or the Forest Department, and these trees show growth similar to that found in the South-Eastern Transvaal. Height growth at ten years of age seldom exceeds 45 feet, but bark thickness is excellent and the trees appear full crowned and healthy in general. There is considerable variation in depth of soil over this area, however, and, where plantations have been established on shallow soils, growth and crown density are very poor indeed. On account of this variability in soil depth and the broken nature of the country, together with the fact that only a relatively small area of suitable land in this region is still available for alienation, it was considered doubtful whether a sufficiently large area of plantations could be established in the Dabaga area to justify the erection of a factory. It was decided, therefore, not to recommend afforestation with wattle in this region unless the scheme proposed for the Ubena Grasslands surrounding Njombe to the south proved a success, when a more detailed reconnaissance of this area might be undertaken to find, if possible, the 25,000 acres necessary to support a factory unit of minimum size.

Sao Hill Region.

A brief inspection of this area was made, but, from an examination of the few existing wattle stands and belts which occur, it was considered that the rainfall over much of this region was probably rather too low for successful wattle cultivation, while the area of available land in the moister portions was too small to support a factory unit.

Ubena Grasslands.

This region comprises the greater portion of the main Southern Highlands plateau, which begins at a point about 120 miles south of Iringa and extends to the Livingstone Mountains at the northern end of Lake Nyasa. The plateau is gently undulating, with an average altitude of 6,500 feet above sea-level, but is much dissected by a complex system of streams and rivers, most of which drain towards the east and south-east. The climatic conditions over the main plateau are similar to those of the Dabaga area, but along the escarpment to the east the rainfall may be as high as 80 inches per annum. Soils on the plateau top are fairly deep and richer in organic matter than those on the sides of the numerous valleys, while the latter tend also to be eroded to a greater or lesser extent and, in some cases, are unlikely to carry successful plantations. The vegetation consists mainly of grasses, with patches of low shrubs and occasional trees on the better soils, while scrub forest is found at the heads of many of the valleys.

A brief preliminary reconnaissance revealed that Njombe Village lies roughly at the centre of that portion of the plateau which appears most promising for the establishment of a wattle project. Three main trunk roads radiate from Njombe, north-westwards to Mbeya, northwards to Iringa, and south-eastwards to Songea, and minor roads branch off from these to Kipengere and Kidugala to the west, Lupembe, Jacobi, and Kifanya to the east, and Uwemba to the south. Three large areas to the north and east of Njombe had been alienated some time previously for European settlement and these formed the starting point for the survey. One of these areas had been subdivided into 5,000-acre farms, none of which was occupied at this time, while the other two areas had been offered on lease to form the nucleus of a wattle project contemplated by commercial interests who, however, did not proceed with the project and no actual planting had been carried out.

After the preliminary reconnaissance, a period of ten days was spent in a detailed examination of those areas which appeared suitable for wattle growing. From the three blocks, comprising approximately 90,000 acres, which were already alienated, a total of only 14,500 acres was selected as suitable, much of the block which had been subdivided into farms, though undoubtedly suitable for wattle, being ignored on account of its relative inaccessibility and lack of road communications. A further 30,000 acres of unalienated land, flanking several of the roads mentioned above, was finally selected as suitable for wattle and it was recommended that an area of approximately 40,000 acres of the total of 45,000 acres of plantable land surveyed be alienated for the establish-

ment of a wattle project to supply an 800-ton factory unit. Since the greater proportion of the plantable land lay to the north of Njombe, it was decided to recommend the siting of the factory at a point on the Iringa road some seven miles north of the village and not at the village itself, as had been contemplated originally. The land selected for the main project is that most conveniently situated in relation to the proposed factory site, but there is, in addition, an equally large area of plantable land composed of small scattered blocks at distances up to 40 miles from the factory site. These, it is hoped, will ultimately be planted up by Natives and European settlers. When supplementary supplies of bark from sources outside the main project warrant it, the factory will be enlarged and provision for such enlargement will be made at the outset. Transport of the finished extract under existing transport arrangements will be relatively costly, since this will involve a road haul of 310 miles by lorries to Dodoma and a rail haul of 288 miles from there to the coast. It is hoped, however, that in the reasonably near future a new railway line will be constructed from Kilosa to Ifakara to tap the rich agricultural area of the Ulanga Valley, and that this line will be extended through Makumbako to Mbeya to link up with the Northern Rhodesian railways and provide a strategic rail connection to the south. If this transpires, the road haul from factory will be about 45 miles, with a considerable reduction in total transport costs.

It may be mentioned that measurements of sample plots laid out in several of the small Native Authority plantations, which have been established near Njombe over the past 12 years, indicate that yields of green bark ranging from 6 tons per acre on the poorer to 8 tons per acre on the better sites can be expected. Analyses of bark samples, carried out by the Chemical Laboratory of the Natal Tanning Extract Co., Ltd., indicate that the bark from this area is extremely rich in tannin and closely resembles bark from the South-Eastern Transvaal in general properties.

A detailed scheme for the main project, including a planting plan, silvicultural recommendations, and an outline of probable staff and labour requirements, was drawn up and submitted at the conclusion of the survey, and the Institute has since learned that the Board of the Colonial Development Corporation has decided to proceed with the project along the lines suggested.

Vipya Plateau of Nyasaland.

On arrival at Zomba on the 7th May, arrangements were made with the Director of the Central African Region of the Colonial Development Corporation for the writer to fly on the following day direct to Mzimba in the Northern Province, which had been selected as a base for the survey of the Vipya Plateau. Since there is only one road traversing the plateau and the country is very broken and virtually unexplored, it was decided to make a preliminary survey from the air in order to select potentially suitable land, which could afterwards be inspected on the ground.

The Vipya Range runs along the western shore of Lake Nyasa from Mt. Wanjati in the south to the Kawozya Peaks in the north, a distance of some 150 miles. These mountains rise fairly steeply within a few miles from the narrow strip of low-lying land along the lake shore to altitudes of over 6,000 feet, except at a point just north of Nkata Bay where there is a break in the range through which runs the road linking Nkata Bay with the main road through Mzimba to the north. The true Vipya, however, is a plateau some 60 miles in length and 30 in width forming part of the Vipya Range and lying due west of Chinteche on the lake shore. The Vipya consists in the main of gently undulating grassland dissected by numerous streams and with occasional rocky massifs rising abruptly from the general level of the plateau, which has an average altitude of about 6,000 feet. Another plateau, the Nyika, about 25 miles square and ranging in altitude from 7,000 to 8,000 feet, lies near the northern end of the Range some 50 miles north of the Vipya. This resembles the Vipya in general vegetational characters, but lacks the frequent bosses of rock which characterize the former, though it is also much dissected by streams.

A detailed aerial survey of the Vipya and Nyika involving four hours of flying time was carried out in the afternoon of the 8th and the morning of the 9th May, and a tract of country in the Vipya, south-east of Mzimba and near the Perekezi Forest Reserve, was selected as meriting a ground survey. In general, the Vipya proved disappointing

from the air since it appeared unlikely, in view of the frequent occurrence of surface outcrops of sheet-rock, that many reasonably large and compact blocks of land suitable for afforestation could be found within a workable radius of a centrally situated factory site.

The ground survey of the tract selected from the air was begun on the afternoon of the 9th and continued until the 14th May. This survey revealed a total of approximately 16,000 acres of plantable land, in two fairly compact blocks, and it was recommended that a more extensive ground reconnaissance be carried out by the Corporation's own staff in the vicinity of this area in an endeavour to find sufficient additional land to support a factory unit. Unfortunately the survey under report was carried out at the end of the rainy season, when the luxuriant grass growth made it extremely difficult to estimate on the ground the amount of sheet-rock present, and it is highly probable that the above estimate of 16,000 acres of plantable land will prove to be over-optimistic. It has been recommended, therefore, that the next survey be undertaken towards the end of the dry season, when most of the grass will have been burnt by the fires which sweep this country annually at this time, and stone outcrops will be more readily seen.

Three small pilot plots of black wattle established on the plateau by the Forest Department some four years ago were inspected and found to be comparable in growth and appearance with wattle of the same age in the Union. In view, however, of the quantity of rock outcropping on the area seen from the air, it seems probable that the area required to support an extract factory may have to be made up of a number of relatively small and dispersed blocks. This will involve maintenance of a very great length of perimeter fire belts and construction and maintenance of a considerable mileage of road communications through rather broken country, the cost of which may render the project uneconomic. In addition, arrangements for the transport of finished products to the coast are at present rather indeterminate, the alternatives being either to utilize the Mozambique Railways and export from Beira or to await the construction of a projected railway from Lindi or Mikindani on the Tanganyika coast to Mbamba Bay on Lake Nyasa. Either alternative involves the use of lake transport from Nkata Bay, which is the only feasible outlet from the Vipya.

In view of the above considerations it was recommended that the idea of establishing a wattle project in this region should be abandoned for the present, unless a more detailed survey of the Vipya and Nyika Plateaus revealed the existence of a sufficiently large area of plantable land in a few compact blocks within a reasonably small radius of a suitable factory site. It was thought that later, when the development of this area has progressed further as a result of the establishment of other projects sponsored by the Corporation, and when the transport position has been clarified, the possibility of establishing a wattle growing project might be considered again.

It may be pointed out that this tour made possible the collection of much useful information on conditions in the countries visited, and it is felt that the experience gained in carrying out these surveys will be of great value in dealing with advisory work of this nature in future. In conclusion, the writer wishes to place on record his appreciation of the invaluable assistance rendered to him during this tour by officials of the Governments of Tanganyika and Nyasaland, which greatly facilitated completion of this survey in the time available.

THE VALUATION OF WATTLE PLANTATIONS FOR INSURANCE

By S. P. SHERRY

In assessing the value of wattle plantations for insurance purposes on a properly managed estate where there is a complete range of age classes, it is necessary to consider stands at all ages from initial establishment to full rotation age if the cover is to be comprehensive.

The value of a stand at the time of establishment is usually assumed to be equal to the cost of establishing it, i.e., the cost of soil preparation and planting. Similarly, the value of a plantation at maturity is normally taken to be the market value of the bark and timber crop less the cost of exploitation. Though these bases of valuation may be generally accepted, there is often controversy regarding the true value of stands at intermediate ages, and especially in the case of stands which are destroyed by fire at an age when the bark is not yet mature enough to be saleable.

Text books on forest valuation present two methods of calculating the value of an immature plantation ; one gives the *cost value*, the other the *expectation value*. The cost value is obtained by bringing forward all costs at some rate of compound interest and deducting from the total the value of all income brought forward in the same manner. The expectation value is obtained by discounting all future returns at some rate of interest and deducting the discounted value of all future costs. For any given set of costs and returns over any given rotation there is a rate of interest which, when used for compounding or discounting, will equalize the cost and expectation value at any given intermediate age during that rotation. Furthermore the rate of interest which equalizes the cost and expectation values is the financial yield of the plantation or, in other words, the rate realized on all money spent on the plantation, taking into account all items of expenditure and income over the rotation period adopted. The financial yield of a plantation is readily determined by the Faustmann equation

$$S = \frac{Yr + \Sigma Ta \times 1{\cdot}0p^{r-a} - C \times 1{\cdot}0p^{r}}{1{\cdot}0p^{r} - 1} - \frac{e}{0{\cdot}0p}$$

where S is the value of the land, Y the net financial return at maturity, Ta the net return from thinnings in the year a, C the cost of establishment, r the rotation period, e the recurrent annual costs of management, and p the financial yield. It should be noted here that land value may be assessed either on original cost or on current sale value and it is important to decide which of these values should be used to represent S in the above equation, since the lower the value of S the higher will be the financial yield. It is considered that the use of estimated current market value rather than original cost of land will result in fewer anomalies and place all stand valuations on a more generally comparable basis. The values for S given below should therefore be regarded as market values.

In the case of a wattle plantation managed on a ten-year rotation in which costs are incurred at establishment and in unremunerative tending operations during the first, second, and third years, the above equation would be expanded as follows :—

$$S = \frac{Y_{10} - (C \times 1{\cdot}0p^{10} + C_1 \times 1{\cdot}0p^{9} + C_2 \times 1{\cdot}0p^{8} + C_3 \times 1{\cdot}0p^{7})}{1{\cdot}0p^{10} - 1} - \frac{e}{0{\cdot}0p}$$

If the following values are substituted for the symbols in this equation, the financial yield is found to be 13·11 per cent. when the land value is £5 per acre and 10·36 per cent. when the land value is increased to £10 per acre.

Net final yield Y_{10}		=£42 per acre
Cost of pre-stripping hoeing, preparation of seed-beds, and sowing	C	=£1 per acre
Cost of spacing, weeding, and pest control in the first year ..	C_1	=£1 13s. per acre
Cost of spacing, weeding, and pest control in the second year ..	C_2	=15s. per acre
Cost of spacing in the third year	C_3	=7s. per acre
General overheads, depreciation of equipment, and fire protection	e	=£1 per acre

By substituting the values derived above for p, the cost value of the plantation at any given age may be calculated from the following formula in which x represents the age concerned.

$$(S + C)1{\cdot}0p^x + C_1 \times 1{\cdot}0p^{x-1} + C_2 \times 1{\cdot}0p^{x-2} + C_3 \times 1{\cdot}0p^{x-3} + \frac{e(1{\cdot}0p^x - 1)}{0{\cdot}0p} - S$$

Again substituting the figures given above for the appropriate symbols in this formula, the cost values per acre of this plantation at successive ages from 1 to 10 years are found to be as shown in the following table for land values of £5 and £10 per acre respectively. A schedule of valuation, incorporating arbitrary values for the plantation over the period during which the crop is not marketable and estimated sale values thereafter, which has been suggested as a possible basis for insurance valuation, is incorporated in the table for purposes of comparison.

Age of Trees in Years	Computed Cost or Expectation Value per Acre		Suggested Insurance Valuation per Acre
	S = £5	S = £10	
	£ s. d.	£ s. d.	£ s. d.
1	4 8 9	4 15 9	2 0 0
2	7 8 6	8 1 6	4 10 0
3	10 8 0	11 5 9	4 10 0
4	13 8 6	14 10 0	6 0 0
5	16 16 9	18 0 0	6 0 0
6	20 14 0	21 18 9	7 10 0
7	25 1 6	26 5 0	36 0 0
8	30 0 0	31 0 0	38 0 0
9	35 12 0	36 5 0	40 0 0
10	42 0 0	42 0 0	42 0 0
Total value per age class unit ..	£205 16 6	£214 1 9	£186 10 0

It will be noted that the computed values show a regular, but rising rate of increase over the ten-year period, unlike the suggested insurance values, which increase disproportionately between the sixth and seventh year, owing to the employment of arbitrary cost values up to the sixth year and estimated exploitation values thereafter.

The computed values undoubtedly give a truer picture of the loss suffered by a grower when a stand is destroyed at an age before the bark is mature enough to be marketable than do the values suggested for insurance purposes. The former not only cover all costs incurred plus compound interest, but also include compensation for the loss of time involved in replacing such a stand, based on its ultimate expectation value, whereas no such compensation is provided by the latter schedule of values.

Because of the fundamental difference in form between the compound interest and growth increment curves, however, the computed values do not provide a sufficiently accurate expression of the loss incurred when a stand is destroyed at an age after the

bark becomes saleable. The former curve rises with increasing increments from the sixth to the tenth year whereas in the latter the increments over this period tend to decrease. If it be granted that the computed values up to the sixth year are true values, then a more accurate estimate of value thereafter will be obtained by fitting a normal increment curve to the cost value curve after the sixth year so that this culminates at the final yield value. If this is done in the case cited above, the values for the last four years of the rotation may be amended as follows :—

Age of Trees in Years	Computed Value per Acre		Amended Value per Acre	Suggested Insurance Valuation per Acre
	$S = £5$	$S = £10$		
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
7	25 1 6	26 5 0	27 0 0	36 0 0
8	30 0 0	31 0 0	34 0 0	38 0 0
9	35 12 0	36 5 0	39 0 0	40 0 0
10	42 0 0	42 0 0	42 0 0	42 0 0

This amendment would have the effect of increasing the total valuation per unit set of age classes to £215 3s. 0d. in the former case and £220 11s. 9d. in the latter, which exceed the suggested insurance valuation by £28 13s. 0d. and £34 1s. 9d. per 10-acre unit respectively. In view of the relatively small differences between the computed values at these ages when land values are £5 and £10 respectively and the fact that the amended values are higher than either of the computed values at 7, 8, or 9 years, it is considered that these amended values may, for the purposes of this example, be taken to apply irrespective of whether the land value is £5 or £10.

The computed values quoted above should not be taken as necessarily representative of average values over the industry as a whole, but merely as indicating the approximate trend of values per acre throughout the life of a plantation. It will be obvious that no two plantations are likely to have exactly the same value at a given age, having regard to differences in the cost of land, in working costs, and in final yields per acre, but it is felt that the method suggested above can be used to advantage by any grower desirous of securing fully comprehensive insurance cover over his plantations.

NOTES ON THE CHEMICAL CONTROL OF THE WATTLE BAGWORM

(*ACANTHOPSYCHE JUNODI* HEYL.), 1949-1950

By L. L. J. OSSOWSKI

Attention has for some time been concentrated upon aerial application of insecticides for the control of wattle bagworm, since this was considered to be the only way of dealing with large areas of infested wattle plantations. There is, however, an alternative approach to this problem based on the habits of this insect.

The bagworm begins its infiltration from outside the plantation and is carried in by prevailing air currents. It tends, therefore, to follow established routes, passing through gorges and " ballooning " spiderwise along block division lines, roads, fire-breaks, etc. Preliminary surveys in 1949 showed that penetration into the block in the first year of infestation does not extend beyond 12-15 yards. Deeper penetration takes place in the subsequent years.

The most opportune time for combating the bagworm would clearly be at the earliest stage of invasion when infestation centres are small and mainly confined to the outside trees of the blocks. This seems to call for perimeter spraying by means of mobile equipment moving along existing roads, fire-breaks, and headlands.

In 1948, small-scale experiments, carried out by the Entomologists of the Cedara College of Agriculture with hand-operated equipment, showed that a 0·25 per cent. solution of gamma-benzene hexachloride in a diesel oil, when atomized at the rate of approximately 3-4 gallons per acre, is effective against bagworms in the first two instars.

Experimental Methods.

In the 1949-1950 wattle bagworm season, field trials were conducted with several concentrations of benzene hexachloride and of Toxaphene, a chlorinated camphene, in solution in the mineral oil Diesoline. The benzene hexachloride was used, and all concentrations are expressed, in terms of the gamma-isomer as indicated by the manufacturers. The concentration of Toxaphene is in terms of the commercial product as supplied.

A machine that seemed suitable for the application of the insecticide under the specific conditions was the Todd Insecticidal Fog Applicator (Tifa), a model of which became available towards the end of the year and was used throughout the trials reported here. In the first experiment, the apparatus was mounted on a trailer drawn by a jeep, but this proved impracticable as it hindered easy manoeuvring at turning points. In the two later experiments, when the machine was mounted on the jeep, its handling was much simplified, but the weight (950 lb.) made the movement of the jeep difficult on wet ground.

The average rate of delivery of the insecticide was three gallons per acre with the machine travelling at four miles per hour. The reputed particle size at this output rate was 120-160 microns, but this was not verified. Whole plots of trees were sprayed, receiving one, two, or three applications to investigate how best to obtain the most effective cover. Benzene hexachloride was used at 2, 3, and 4 per cent. gamma-isomer and Toxaphene at 2·5, 5, and 10 per cent.

It must be appreciated that in the case of fog treatments, as in fumigation, not only the concentration of the spray is important, but also the length of time the insect and its food material are exposed to it. Consequently, in Experiments II and III, the length of time the fog hung in the tree-crowns, as judged by visual observation, was measured by a stop-watch.

Assessment of Mortality.

Separate sample trees were selected at random for the assessment of the natural mortality and " fall-off " and the mortality and " fall-off " caused by the insecticide.

One or two hours before spraying operations commenced, 50 per cent. of the sample trees selected for assessing the natural mortality count were stripped of all bagworms for laboratory examination. In order to assess the natural " fall-off ", all bagworms left on the remaining 50 per cent. of the sample trees were counted. These bagworms were again counted and collected on the day when bagworms were taken from the second lot of sample trees selected for the assessment of mortality caused by the insecticide.

On the last-mentioned sample trees, all bagworms were counted once shortly before spraying and again, some after 24 hours and some after 6 days in one block and after 5 or 6 days in other blocks. During the second count, bagworms were collected for laboratory examination. Thus the " fall-off " caused by spraying could be assessed shortly before starting the actual laboratory examination for mortality.

In Experiment I, the number of sample trees for assessing the natural mortality and the mortality caused by the insecticide, including the respective "fall-off" in each case, was 4 and 10 respectively for each block. The average area of the block sprayed was 50 acres.

The size of sample plots in Experiments II and III was one acre in the former and half an acre in the latter, and the number of sample trees per plot was 8, with the exception of one plot, where the number was 7.

In the laboratory, the collected bagworms were slowly exposed to moderate heat from a spherical lamp. Bagworms which were motionless were counted as dead only after this was confirmed by dissection, as bagworms during moulting periods and in their prepupal stage are outwardly fairly motionless.

The results thus obtained were finally corrected for " fall-off " and natural mortality.

Plot Layout, Treatment, and Results.

Experiment I — Highlands Estate. Commercial Spraying with Benzene Hexachloride, Mid-December, 1949.

Six blocks were sprayed with 4 per cent. gamma-BHC and one each with 2 per cent. and 3 per cent. As no sample trees were kept under close observation during spraying, there is no check on the length of time the crowns were enveloped in fog. The results given in Table I are derived from the pooled date of whole plots. A great variation in mortality is evident, ranging from 48·6 per cent. to 100·0 per cent. with 4 per cent. concentration, 27·3 per cent. to 44·8 per cent. with 3 per cent., and 45·3 per cent. to 88·3 per cent. with 2 per cent.

The lowest mortality was obtained with a 3 per cent. concentration. In this test, the fog rose very rapidly, covering only two rows next to the Tifa.

Table I—Commercial Spraying with BHC.

Treatment No.	Block No.	BHC %	No. of bagworms sampled	No. of bagworms per tree	Instars	Collected after spraying	Range of mortality %	Final (corrected) kill %
1	62	4	370	95	2—5	24 hours	48.6— 60.9	54.9
2	62	4	1418	95	2—5	6 days	49.6— 81.6	68.0
3	61	4	200	50	2—5	5 days	———	51.0
4	65	4	742	53	3—5	6 days	66.6—100.0	84.2
5	55	4	320	84	3—5	6 days	68.1— 99.7	85.6
6	56	2	327	81	3—5	5 days	45.3— 88.3	64.2
7	56	3	549	137	3—5	5 days	27.3— 44.8	35.3
8	56	4	373	93	3—5	5 days	58.7— 78.7	66.2

Comparing mortality between doses of 2, 3, and 4 per cent. in block 56, the highest mortality (88·3 per cent.) was achieved with 2 per cent., and not as was to be expected with 4 per cent. The cover obtained with the former was apparently better than that with the latter.

Experiment II — Mistley Estate. Experimental Spraying with Benzene Hexachloride, 18th January, 1950.

Three plots were sprayed with 2 per cent. gamma-BHC once, twice, and three times respectively, and three plots were treated in the same way with 3 per cent. gamma-BHC. In this experiment, all sample trees were kept under observation during spraying and wherever possible the length of time they were enveloped in fog was measured with a stop-watch.

The results obtained in this way from single sample trees, and given in Table II (treatments 1, 3, 5, 6, 8, 11, and 13), have to be taken into consideration in assessing the toxic effect of the various concentrations of the insecticide. The average result from the pooled data of the whole plots, as given in Table II (treatments 2, 4, 7, 10, 12, and 14), will only give an indication of the effect of the insecticide, and would be higher if a good cover were obtained through the whole sample plot.

Table II—Experimental Spraying with BHC.

Block 10. 2nd and 3rd class site quality.
Area 114 acres ; planted 1943, present stocking 710 s.p.a.
Size of plots—1 acre.

Sprayed 18th January, 1950 ; collected 23rd January, 1950 (5 days).

Treatment No.	Insecticide and No. of sprayings	Sample trees	Enveloped in fog Secs.	No. of bags Total	No. of bags Per tree	Range of mortality %	Final (corrected) kill %
1	2% BHC, once	1	Completely for 15		24		61.1
2		All 8		460	57.5	25.8—71.2	61.8
3	2% BHC, twice	1	Once for 15, second time for 10		49		65.2
4		All 8		115	14.3	35.3—69.7	61.9
5	2% BHC, three times	1	Partly covered once for 15		16		54.5
6		1	Not covered		27		28.8
7		All 8		380	47.5	28.8—50.0	38.3
8	3% BHC, once	1	Slightly enveloped in fog		31		54.8
9		1	Completely enveloped for 30		78		100.0
10		All 7		480	68.5	25.0—100.0	72.6
11	3% BHC, twice	1	Enveloped once for 10, second time for 10		50		76.8
12		All 8		310	38.7	50.2—100.0	84.1
13	3% BHC, three times	1	Once partly only for 5		85		37.5
14		All 8		276	34.5	32.2—63.0	58.1

21% of the bagworms collected from unsprayed control trees were 1st or 2nd instar (mostly dead), 65% 3rd or 4th instar, 13.8% 4th+ instar, and 0.2% were prepupal stage.

While triple spraying of 3 per cent. gamma-BHC only partly enveloping the whole sample tree for five seconds gave a subsequent mortality of only 37·5 per cent., a 2 per cent. concentration sprayed once and covering the sample tree for 15 seconds gave a mortality of 61·1 per cent. On the other hand, 3 per cent. gamma-BHC sprayed once and covering the sample tree for 30 seconds resulted in a mortality of 100 per cent.

A plot sprayed three times with an insecticide should theoretically show a better covering than a plot sprayed only once, but in this particular case the wind was extremely unfavourable and the cloud rose almost vertically, only partly enveloping the first row of trees, adjacent to the sprayer.

It was noticed in this experiment that a large proportion of bags, mainly of the last instars, was empty. Bags collected before spraying operations did not show this tendency and only 1 out of 351 bags was found empty. It may be assumed, therefore, that the bagworms were not killed directly after spraying, but left the bag after the insecticide saturated it. These bagworms, left without a bag in the later instars, will no doubt die (small-scale laboratory experiments have proved this) and empty bags found after spraying were therefore counted as dead bagworms.

Experiment III — Spring Grove Estate. Experimental Spraying with Toxaphene and Benzene Hexachloride, 31*st January,* 1950.

Two plots were sprayed with 2·5 per cent. Toxaphene once and twice respectively; two other plots were sprayed once, with 5 and with 10 per cent. Toxaphene respectively; one plot was sprayed once with 4 per cent. gamma-BHC; and one plot once with Diesoline alone.

This experiment was started somewhat late as even in Spring Grove, which had this season a later hatching, nearly 2 per cent. of bagworms were already in their prepupal stage. Even 10 per cent. Toxaphene, enveloping the sample tree for 12 seconds, did not kill these bagworms as the spray was unable to penetrate the very strong and dense silken lining of the bag. Individual sample trees were kept under observation and the time the trees were enveloped in fog was measured.

Data from treatments 1-4, 6-8, 10, 11, 13-16, 18-20, 22, and 23, given in Table III, represent the results of experiments with comparable time factor to show the correlation between time and mortality and also, where possible, between concentrations of the insecticide. The data of treatments 5, 9, 12, 17, 21, and 24 are derived from the pooled results of whole plots.

Toxaphene at 2·5 per cent. distributed once and enveloping two sample trees for 5 and 12 seconds respectively gave a mortality of 48·4 and 66.3 per cent. A 2·5 per cent. Toxaphene drift, covering the tree for 15 seconds, gave a mortality of 50·1 per cent. A double application of 2·5 per cent. Toxaphene resulted in a good cover. Two sample trees, one enveloped for 12 seconds in fog and the other for 12 seconds in direct fog plus 7 seconds in returning drift, gave a mortality of 79·0 and 94·5 per cent. respectively.

The application of 5 per cent. Toxaphene gave poor results as the fog rose too rapidly, covering only the two rows nearest to the sprayer. Sample trees slightly enveloped in drift showed a mortality approximately 25 per cent. above the natural mortality.

Toxaphene at 10 per cent. with fairly good cover gave a good result, but comparing data of treatments 8 and 16 it is seen that 10 per cent. Toxaphene gave about the same kill as 2·5 per cent., the time factor being approximately the same in each case.

Toxaphene at 2·5 per cent. (treatment 7) gave a higher kill than 4 per cent. gamma-BHC (treatment 20). Again, Diesoline alone, sprayed as control, gave a mortality 10 per cent. above the natural mortality in cases where trees were enveloped for 4 seconds.

Discussion.

So far both BHC and Toxaphene seem to be effective against bagworm. BHC appears to act more quickly, the difference in mortality of specimens collected 24 hours and 6 days after spraying with BHC being only 13·1 per cent. Toxaphene, however, seems to have the greater ultimate toxicity.

It will be noted that the mortality is very high (up to 100 per cent.) in the first 4 instars, and decreases in later instars, but control is still satisfactory provided a good cover is obtained. It may be assumed from the results obtained that a 2 per cent. concentration of BHC and 2·5 per cent. Toxaphene can effectively control the bagworm if an even distribution through the foliage is achieved, and also that spraying twice with a lower concentration will give better results than spraying once only with the same

Table III—Experimental Spraying with Toxaphene and BHC.

Block 3. 2nd class site quality.

Area 42 acres ; planted 1947, present stocking 580 s.p.a.

Size of plots—0.5 acres.

Sprayed 31st January, 1950 ; collected 6th February, 1950 (6 days).

Treatment No.	Insecticide and No. of sprayings	No. of tree	Enveloped in		No. of bagworms per tree	Instars				Final (corrected) kill %
			fog Secs.	returning drift Secs.		1 + 2	3 + 4	>4	Prepupal	
1	2½% Toxaphene, once	1	0*		77	13	44	18	2	27.5
2		7	5		28	3	23	2	0	48.4
3		6		15	123	28	93	2	0	50.1
4		4	12		57	12	39	5	1	66.3
5		8 trees			433	83	271	69	10	49.2
6	2½% Toxaphene, twice	5	0		46	15	15	15	1	21.6
7		4	5+7		179	70	80	20	9	79.0
8		2	2+10	7	105	48	40	10	7	94.5
9		8 trees			1174	339	585	225	25	56.7
10	5% Toxaphene, once	5	0		32	5	15	10	2	18.8
11		7		Slight	97	27	60	6	4	55.7
12		8 trees			429	93	257	60	19	47.7
13	10% Toxaphene, once	1	0		243	43	122	70	8	35.4
14		4	5		95	11	75	7	2	71.8
15		8	9		39	4	34	1	0	84.3
16		3	12	10	126	31	60	34	1	95.4
17		8 trees			730	160	413	140	17	45.0
18	4% BHC, once	2+8	0		271	70	170	25	6	29.0
19		4	3		112	28	75	9	0	59.8
20		5	9	3	25	7	17	1	0	76.9
21		8 trees			1019	258	652	99	10	42.3
22	Diesel oil, once	1	0		182	76	79	27	0	30.8
23		8	4		34	3	16	15	0	40.7
24		8 trees			855	214	502	129	10	30.1

*0 signifies that the sample tree was not enveloped in fog.

Summarized Biological Data.

Total area sprayed Acres	Sampled		Instar %				Natural mortality %				
	Trees	Bagworms	1 + 2	3 + 4	>4	Prepupal	1 + 2	3 + 4	>4	Prepupal	Whole population
6	48	4640	24.8	57.8	15.6	1.9	85.9	24.3	8.9	0	29.3

insecticide at double the strength. Furthermore, toxicity is only one factor, though an important one ; equally important is the cover and even distribution of the insecticide through the crowns.

The Tifa apparatus seems to be suitable for the purpose under certain conditions, but requires some modification. It can only be used on fairly level ground and has a tendency to cut out on steep slopes. The exhaust pipe should have a properly fitted lever to facilitate quick changes of angle of projection with changing atmospheric conditions.

Cloudy, even drizzly, windless days appear to be the most favourable for spraying operations, as the cloud or spray hovers longer in the crowns, thus sufficiently saturating the bags. Sunny days, on the other hand, have the advantage that the bagworm is then feeding partly out of its bag and it is thus more easily killed. Under hot conditions, however, the fog rises too quickly and does not sufficiently cover the whole area.

The mortality in small experimental plots will be lower than in large blocks treated commercially, as the backspray or returning drift in small experimental plots settles down in the buffers, which are not included in the actual experiment, while the drift in large blocks falls on trees within the controlled area, resulting in a higher mortality over the whole block.

Recommendations.

As already mentioned, perimeter spraying at the earliest stage of infiltration offers promise of success. In the event of adopting this method of combating the wattle bagworm, it would in some cases become necessary to alter the existing system of planting distances and the tending of plantations where spraying is likely to take place. Where the boundary of a block is defined by roads or rides and where the plantation marches directly with thornveld, the four outside rows of the block or plantation should be planted and kept in a closer (triangular) spacing than is customary. The trees in these rows should never be pruned and should be only moderately thinned according to necessity, leaving the trees close enough to form an uninterrupted screen of crowns. This dense screen should catch the " ballooning " bagworms, thus concentrating the invasion into confined and easily controlled areas.

In older plantations also, the young wattle undergrowth in these four boundary rows should be left standing to make a more complete screen of the " catch area ".

There are cases where an infestation starts not only along the mentioned routes, but also in the middle of the plantation, brought there by falling air currents. Even in these cases, however, it should be easier to eradicate the comparatively small centres of infestation than infestation of a whole block.

Another factor supporting spraying at an early stage of infiltration, apart from less expenditure and better working of machinery, is the lesser disturbance of the natural equilibrium. It has been shown that 2 per cent. gamma-BHC kills not only bagworms, but also other insects including pollinators, parasites, and predators. Ample evidence of this was seen during the commercial spraying with BHC at Highlands. Roads were littered with different kinds of insects, including hairy caterpillars of the family *Lasiocampidae*, which generally are resistant to contact poisons. Among the killed insects, a large number of beneficial ichneumon flies was found. Hence the larger and more compact the area sprayed, the more harmless and useful insects will be killed. Spraying only the margins of blocks will reduce the area and therefore also this danger.

The essential basis for a successful campaign is an accurate and reliable infestation survey. This should be a summary of the whole season's observations and not of the day preceding the actual report. Also the survey should not be made by car, but on foot or on horseback. The reliability and accuracy of these reports will gain in value where managers and overseers have for a long time worked in the same plantation, thus getting to know the plantation and the infestation centres intimately and in detail.

Present surveys, based on a general estimate of the infestation by bagworms and the visible damage (six grades), with natural mortality assessed on some material sent in by the different wattle estates, are not adequate for the purpose in view. Estimates are dangerous and will not give accurate results, since they are based on the individual judgment of the various surveyors. Better results would probably be achieved if the

damage were correlated with the actual number of bagworms per tree, obtained from stratified samples and the grade of infestation based on the actual number of bagworms found on the tree.

Material sent in for examination should be collected strictly at random and not only from such easily accessible places as, for instance, up to a height of 6 or 7 feet on the outside rows.

It is essential that stratified sampling should be done and that the whole sample tree, whether small or large, should be stripped completely of bagworms. Each sample should be kept separately in a bag and sent for examination, with details as to number of block, age, etc. if these details are not known from a summary sheet. This, of course, will involve much more work, but is absolutely essential if positive and accurate results are to be obtained.

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PUBLICATIONS TO DECEMBER, 1949

Anon .. .. "The Wattle Research Institute Report for 1948 (First Year)." *The Wattle Research Institute*, April, 1949.

Anon .. .. "John Vanderplank and the First Wattle Seed." *The Wattle Research Institute*, May, 1949.

This pamphlet reproduces the original panel painted for the Institute by Peter Leftwich and gives an account of the historical background.

A few copies are still available on application to the Institute.

Martin, W. S. "Freedom from Want". *The Farmer's Weekly*, May 18, 1949.

This semi-popular article discusses the effect of various farming practices upon soil fertility and soil structure. The relation of soil structure to permeability to water, air, and plant roots is outlined, and the influence of suitable grass leys upon the regeneration and maintenance of a good structure is described.

Copies of this paper are available on application to the Institute.

Shaw, H. .. "Possibilities for Co-ordinated Wattle Research in the African Region." *African Regional Scientific Conference*, October, 1949.

The present status and future prospects of wattle research in Africa are discussed, especially in relation to expansion of the wattle industry.

This paper is reprinted on page 24.

The following papers published by members of the Institute staff report earlier work done in other places before they joined the Institute.

Moffett, A. A. (and Hurcombe, R.). "Chromosome Numbers of South African Grasses." *Heredity*, 1949, 3, 369.

Shaw, H. .. (and Steer, W.). "Laboratory Studies on the Toxicity of Hydrocarbon Oils and Similar Substances to the Eggs of Some Common Orchard Pests. I. General Introduction. II. Experiments on the Eggs of the Winter Moth (*Operophtera brumata* L.)." *Journal of Pomology and Horticultural Science*, 1947, XXIII, 1.

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Martin, W. S. "Soil Physics" by L. D. Baver. *The Farmer's Weekly*, October 6, 1948.

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